WKS – Honors
Solubility Curves

Name _____
Period _____

Refer to the solubility curve at the right (Chart G)

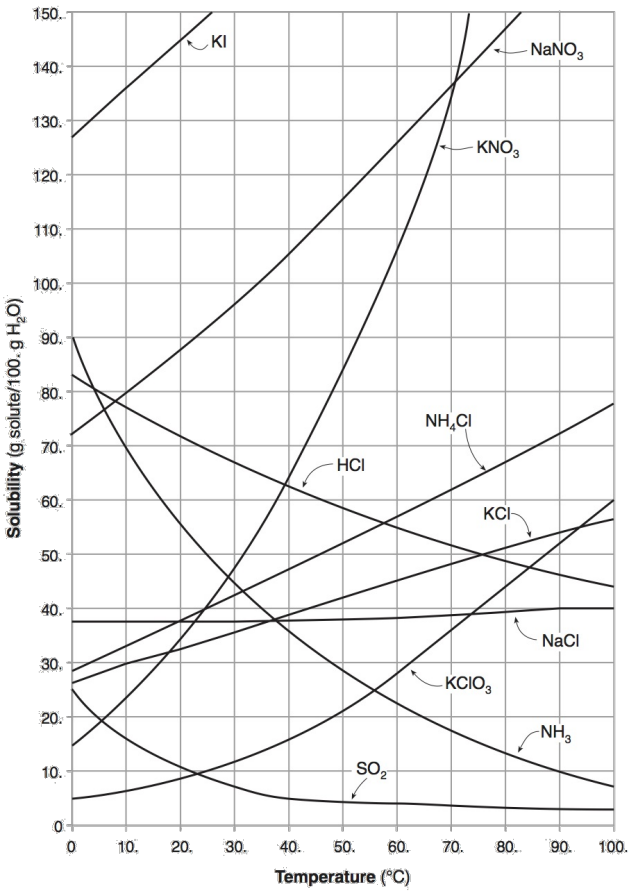
1) What type of solution has contains the maximum amount of solid dissolved in it? _____
2) What type of solution can still have more solid dissolved in it?_____
3) When the temperature increases, does the solubility of solids increase or decrease? _____
4) When the temperature increases, does the solubility of gases increase or decrease?_____.
5) When the pressure increases, does the solubility of gases increase or decrease? _____

6) How many grams of **$NaNO_3$** must be dissolved in 100 g of water to form a saturated solution at 40°C? _____

7) At what temperature can one dissolve a maximum of **60g** of **NH_4Cl** in 100g of water?_____

8) If **120 g of KNO_3** are added to 100 g of water at **40°C**, ...
   a) How many grams dissolve?_____
   b) How many grams stay undissolved? _____

9) If one dissolves **90 g of KNO_3 at 60°C**, what type of solution is formed? _____



10) How could one make a **supersaturated** solution which contains 130g of KNO_3 all dissolved in 100 g of water at 40°C?

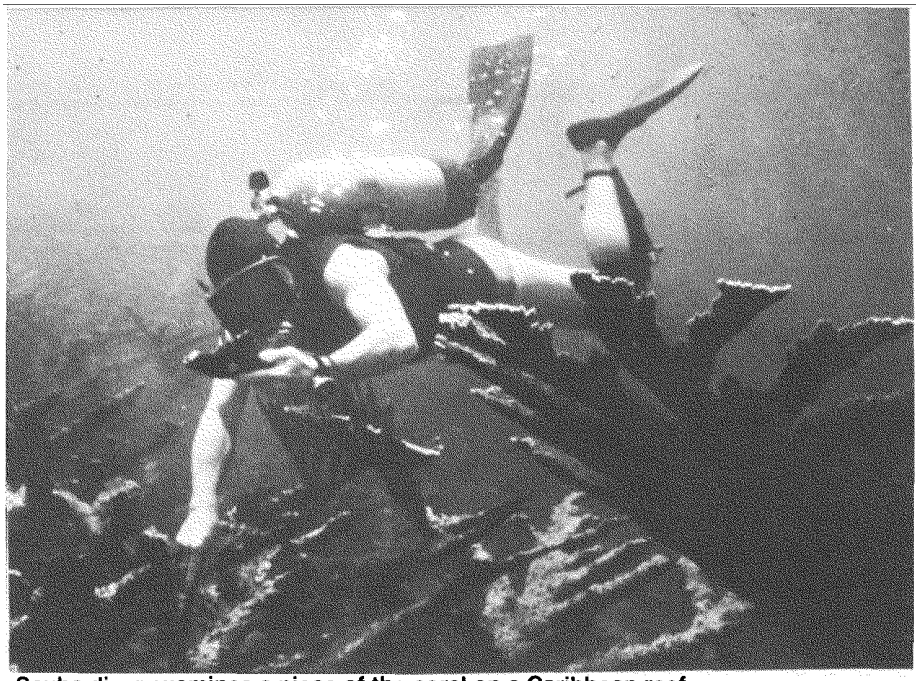
11) List a few ways one could disturb this supersaturated solution and cause the "extra" solid to "crash out" of solution?

12) ***Read the one page article about Scuba Diving on the back of this sheet to answer these questions.***
   a) When a diver goes deep underwater, does more or less nitrogen gas dissolve into his blood? **Explain why.**

   b) What happens to the nitrogen gas when the diver comes up to the surface? Why?

   c) What problems can occur if a diver comes up too quickly after being more than 10 m underwater?

   d) If a diver goes down deeper than 30 m, he could experience what is called nitrogen narcosis. Why does this happen and what are its symptoms?



Scuba diver examines a piece of the coral on a Caribbean reef.

Reading is an excerpt from the article, "Gas Laws and Scuba Diving" *Chem Matters,* Feb 1983

Pressure–Solubility Effects

Not only does the pressure affect the volume of trapped gases, it also influences the solubility of gases in liquids. Divers must be aware of the principles described by Henry's law, which states: *The amount of gas that will dissolve in a liquid at a given temperature varies directly with the pressure above the liquid.*

Henry's law is useful, therefore, in explaining why during a dive any gases entering the lungs are absorbed to a greater extent in the diver's blood. Although this increased solubility of gases in the blood may create no problems during the dive, the diver's body experiences an effect similar to opening a can of soda when the diver ascends rapidly to the surface. This effect can be accentuated if the diver takes a high-altitude plane flight soon after a dive. In particular, nitrogen gas bubbles that form in the blood and other body fluids can produce a multitude of problems. These problems depend on the location of the gas bubbles, the size and number formed, and the way they are transported by the diver's circulatory system. The bubbles can cause localized pain, itching of the skin, breathing difficulty, and can lead to paralysis, unconsciousness, and death.

To minimize gas bubble formation (decompression sickness or "the bends"), divers carefully follow tables prepared by the U.S. Navy that describe the time limits for dives at various depths greater than 10 meters. The essence of the process described by the tables involves ascending to a certain point and then remaining at that depth for a time period to allow some of the dissolved nitrogen to escape. Depending on the initial depth, there may be several of these "hold points" during the ascent. If divers experience decompression sickness, the only mode of treatment is to put them in a decompression chamber, increase the pressure surrounding their bodies, and slowly decompress them back to one atmosphere of pressure.

The increased solubility of nitrogen gas at higher pressures may also have a narcotic effect. Nitrogen narcosis or "rapture of the deep" generally does not occur until divers reach depths of about 30 meters. The symptoms are similar in nature to intoxication by alcohol. The divers have a feeling of happiness, overconfidence, tingling or numbness in their arms or legs, and memory impairment. This narcotic effect of nitrogen is just one of the many reasons divers should never work alone underwater.

Another application of Henry's law involves contaminants such as carbon monoxide (CO) that might be present in the compressed air used by divers. Of course, every attempt is made to ensure the purity of the air in scuba tanks, but if a contaminant is present to the extent of just 1%, its presence is more serious during a dive. For example, at a depth of 40 meters, the pressure is equivalent to about five atmospheres. Because the regulator delivers air at the same pressure as the surroundings, each breath contains five times more contaminant molecules than each breath from that same tank at the surface. This is equivalent to breathing air containing 5% of that contaminant at the surface.

As the pressure increases during a dive, the solubility of oxygen in the blood also increases proportionately. This means that the effects of poisoning by a trace of carbon monoxide contaminant may go unnoticed during a dive since sufficient oxygen is available for normal cellular respiration. However, as divers surface, the solubility of oxygen decreases in their bloodstreams. Because the carbon monoxide–hemoglobin combination is so stable, there may not be a corresponding decrease of carbon monoxide in the blood. If the divers do not have enough hemoglobin available to bond with oxygen cell respiration, they may lapse into unconsciousness.

Temperature–Solubility Effects

Gas solubility is also affected by changes in temperature. Have you ever noticed that as a cold glass of water warms to room temperature, air bubbles form, clinging to the inside of the glass surface? These bubbles are composed of air that was dissolved in the cooler water. Can you use this information to explain why it is dangerous for a diver to take a hot shower after a deep dive?

A scuba diver with a good basic understanding of gas behavior will better appreciate what is happening during a dive. If you are a scuba diver, this understanding could save your life!

References

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